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Host Records and Nest Entry by *Dolichostelis*, a Kleptoparasitic Anthidiine Bee (Hymenoptera: Megachilidae)

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Abstract.—Host-parasite associations were recorded for three species of *Dolichostelis,* a kleptoparasitic anthidiine genus. *D. louisae* (Cockerell) was reared from nests of the megachild bees, *Chalicodoma angelarum* (Cockerell) and *C. campanulae* (Robertson). *D. costaricensis* Friese was reared from cells made by *C. otonita* Cresson. *D. rudbeckiarum* (Cockerell) was observed parasitizing nests of *C. subexelis* (Cockerell). These host records are the first confirmations for any of these parasites. Cocoons of *Dolichostelis* are described and illustrated, sex ratios are calculated, and observations on nest entry by *D. rudbeckiarum* are described and illustrated.

The biologies and taxonomic relations of the parasitic bees in the tribe Anthidiini are relatively unknown. Many undescribed species exist (Parker, unpublished data), and only a few parasites have been associated with their host bees. Anthidine bees are found in all zoogeographic regions and some genera are globally distributed; four genera *(Stelis, Odontostelis, Dolichostelis,* and *Heterostelis)* occur in North and Central America (Hurd et al., 1979; Parker and Bohart, 1979). Hosts of the parasitic American genera are megachilids such as *Osmia, Proteriades, Hoplitis, Ashmeadiella, Anthidium,* and *Megachile* (Hurd et al., 1979, unpublished records). *Odontostelis* parasitizes *Euglossa,* a Neotropical apid (Bennett, 1966).

Dolichostelis is a newly proposed genus from North and Central America. Previously, no host associations were confirmed for any of the six species included (Parker and Bohart, 1979) although Krombein (1967) reared one (*D. louisae* (Cockerell)) from a nest of an unidentified resin-using bee. In this paper, host associations for *Dolichostelis* resulted from three separate studies. First, wooden block traps were placed at several locations near Auburn, Alabama, for a collaborative study of trap-nesting aculeates in cooperation with J. Cane. The design of the traps and methods of rearing the specimens resembled those described by Parker (1985). In the Alabama study, the traps were opened and their contents individually isolated and reared. Adults were weighed after emergence, killed, mounted, and identified. The Costa Rican study was done in cooperation with G. Frankie and S. Vinson, who placed traps for us in the field, employing the same design used in Alabama. In addition, Frankie and Vinson deployed many units of individual stick traps (pine) that had been taped together into bundles bearing several holes sizes/unit (borings of approximately 4.5, 6, 7.5, 10, and 11 mm in diameter). Nests from the stick traps were not opened initially, but they were

individually isolated and all emerging insects were killed and labeled. Adult weights and placement of cells within the nest were not recorded. Observations on *D. rudbeckiarum* were recorded by the senior author from nesting materials placed in his yard in Logan, Utah.

Dolichostelis louisae (Cockerell)

Nests of four species of *Chalicodoma (Chelostomoides)* were recovered from traps placed near Auburn, Alabama, during 1985. Twelve specimens of *D. louisae* (Cockerell) emerged from nests of two species of *Chalicodoma.* An eight-celled nest of *C. angelarum* (Cockerell) had six cocoons of *D. louisae* in the outer-most cells. In one of six recovered nests of *C. campanulae* (Robertson), a single cell was parasitized by this same bee. Three additional nests of *Chalicodoma* were parasitized by *D. louisae,* but since no hosts emerged, specific associations could not be confirmed. The single nest obtained by Krombein (1976) also contained only *Dolichostelis,* but he believed, correctly, that the host bee was a species of *Chalicodoma.*

Cocoons of *D. louisae* bear a nipple dorsally, a feature that characterizes Anthidiini cocoons. Cocoons of *D. louisae* differed from typical *Stelis* cocoons (Fig. 1) by their barrel-shape and lesser amount of silk. The short fecal pellets formed by *D. louisae* larvae differed from the typical ribbon-like strands made by many *Stelis* larvae. Fecal pellets of *D. louisae* were woven into the outermost layer of the cocoon. Such pellets are not incorporated in cocoon formation by *Stelis* larvae. *D. louisae* cocoons were made from three layers of coarse, white silk strands. Inside the first layer, which bore an anterior nipple, a second layer had a conical and hollow nipple; the second layer was made from an amber-colored substance. The third layer was similar in texture and color to the first layer and it covered all the inner surfaces except beneath the nipple. Cocoons averaged 8 mm long and 5 mm wide.

The observed sex ratio was 1.4 females to 1 male and the calculated sex ratio (Torchio and Tepedino, 1980) was 1.06 males to 1 female. Females were only slightly heavier (22.5 mg, SD 7.1 mm, range 14.5–32.7 mg, n = 7) than males (21.2 mg, SD 4.2 mg, range 15.2–26.4 mg, n = 5). Average adult weights of the parasites and their two hosts were compared; average weight of the parasites was 60.7% of *C. angelarum* and 73.3% of *C. campanulae.* All pollen and nectar provisions were consumed in parasitized cells. Thus, differences in weights between host and parasite were attributed to differences in relative proportions of fecal and silken materials produced by their respective larvae. Similar differences in allotments of resources have been recorded for a related parasitic bee, *Stelis depressa* Timberlake, and such behavior may be important in survival of these parasites (Parker, 1984).

Dolichostelis costaricensis Friese

Sixteen nests of *Chalicodoma otonita* Cresson were obtained from the stick traps placed at Lomas Barbudal Biological Reserve, Guanacaste, in Costa Rica. Stick traps were placed in shaded forest locations during the extended season, from December to May. A male of *C. otonita* and a male of *D. coastaricensis* emerged from one of these isolated nests. When the nest was examined, the first cell made by the host contained an empty cocoon of *Dolichostelis.* Apparently, the male emerged from the second cell. In a three-celled nest of *C. otonita,* two empty cocoons of *D. costaricensis* were found in the same host cell and the cell above contained an empty parasite cocoon. Another two-celled *Chalicodoma* nest produced two *Dolichostelis*

adults. Five more *Dolichostelis* emerged from traps with no host emergence, but these nests were probably made by *C. otonita.* One dead female of this parasite was found in a wooden block trap, but no cells of *C. otonita* were successfully parasitized.

The observed sex ratio was 1:1; since adults were not weighed, calculated sex ratios could not be estimated. Cocoons of *D. costaricensis* were similar in formation, size, and color to those of *D. louisae.*

Dolichostelis rudbeckiarum (Cockerell)

For the past several years, a population of *Chalicodoma subexilis* (Cockerell) has nested in several sizes (4, 6, 8 mm in diameter) of borings in pine wood placed on window sills and in the garage of the senior author's home. In 1986, D. Broemling, a graduate student at Utah State University, observed a female of *D. rudbeckiarum* chewing at an entrance plug of a *C. subexilis* nest; it was captured and identified. During the next several weeks in August, other females were noted and the following observations recorded.

Often during the day, females of *Dolichostelis* were seen as they inspected nests of *Chalicodoma.* These small bees were unusually rapid fliers for bees, and darted among the layers of stacked borings. They darted rapidly back and forth horizontally before the faces of the borings from 5–10 cm. The females landed only to inspect resin nests of *Chalicodoma.* They never inspected active nests of other aculeates that used the same sites such as *Megachile, Osmia, Eumegachile, Euodynerus, Isodontia,* and *Trypoxylon,* none of which use resin in nest construction. During nest inspection, *Dolichostelis* females either entered opened nests or briefly examined the entrance plug.

At 8:00 P.M. (MDT, 8 August 1986), a female was observed chewing on a resin entrance plug, and F. Parker recorded and photographed its activities. The parasite worked at the entrance plug for several hours, removing tiny pieces of resin which it then stuck on the wood surrounding the boring. As the parasite removed small pieces, it worked most of the resin into an extended lip (Fig. 2). After about two hours, the parasite bent the lip down with the weight of its body while chewing at the top of the plug. During the entire process, the parasite deposited glistening droplets from the tip of its abdomen onto the surface of the resin plug. After each deposition, it then turned around and chewed the area where the droplet was deposited. Apparently, this substance, acting as a solvent, enabled the parasite to soften and mold the resin. Also, this liquid may aid in preventing resin from sticking to the mouthparts, since the parasite frequently groomed and cleaned its head. After sunset, a small lamp was placed near the glass to illuminate the nest surface. The parasite seemed undisturbed by the light since it continued to work. After the

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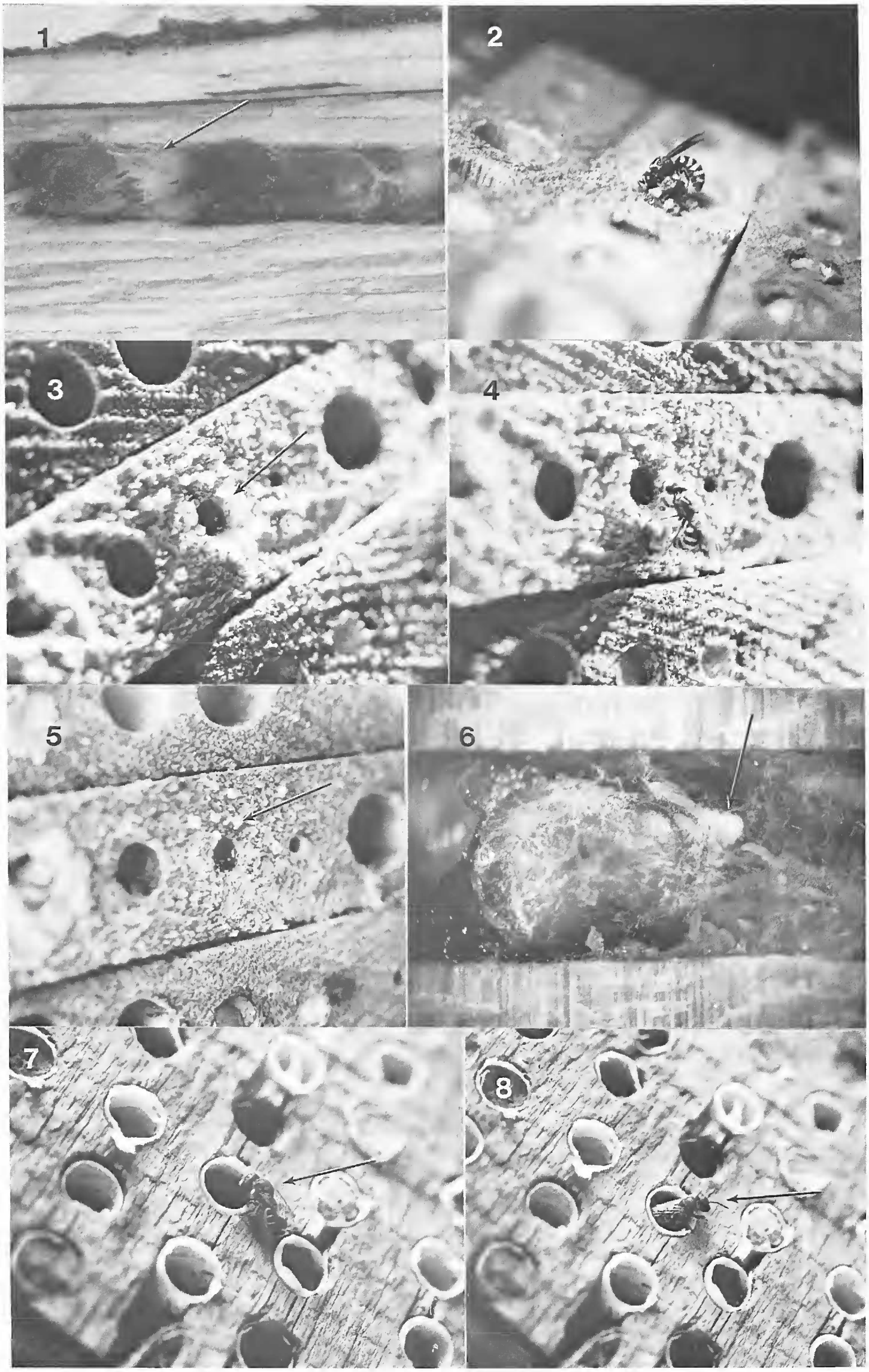
Fig. 1. Portion of a nest of *Chalicodoma angelarum* (Cockerell) made in a trap block and with two cells containing cocoons of *Dolichostelis louisae* (Cockerell). Fig. 2. Female of *Dolichostelis rudbeckiarum* (Cockerell) opening sealed entrance of a nest of *Chalicodoma subexilis*. About 9:00 P.M. (MDT). Fig. 3. Same nest at 8:00 A.M. the following day and with the female parasitic bee resting just inside the entrance. Fig. 4. Same nest being closed by the parasite. Fig. 5. Same nest after parasite had finished closing the entrance. Note the small pellets of resin adjacent to the plugged opening; such pellets indicate nest parasitization by *Dolichostelis*. Fig. 6. Cocoon of *Dolichostelis rudbeckiarum*. Fig. 7. Female of *Chalicodoma subexilis* inspecting a previously capped nest. Fig. 8. Female of *Chalicodoma subexilis* depositing droplets from its abdomen around rim of nest plug.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parasite finally gained entrance to the nest, it proceeded to remove more resin from within the nest. Later, it removed what appeared to be a small amount of host provision. The female continued its back-and-forth entry into the boring until after 12:00 A.M., when observations were discontinued.

The next morning, at 8:00 A.M., the nest was checked and the female was resting just inside the entrance (Fig. 3). As soon as sunlight struck the nest, about 9:00 A.M., the parasite resumed its activities. Soon, it commenced refilling the entrance with the small pieces of resin it had previously stuck adjacent to the opening (Fig. 4). By hanging vertically from above the hole, the parasite grasped the resin lip protruding from the hole and pulled it up and into place as if it had been hinged at the base. Then, the nest plug was smoothed across with more resin (Fig. 5). The parasite finished working at 9:55 A.M. and flew away. The nest was left on the ledge to be opened in the laboratory on Monday, but before removal, the original owner returned to the nest, opened the entrance, and began removing pollen and nectar. Sometime later, it again plugged the nest, but this time using masticated leaf pulp mixed with resin for the final closure. Upon opening in the laboratory, the nest contained a single cell with a large egg lying across the pool of nectar and pollen; this egg hatched into a *Chalicodoma* larva. Twenty other *Chalicodoma* nests were opened, including several with evidence of parasite entry, but only one contained parasite cocoons.

Cocoons of *D. rudbeckiarum* (Fig. 6) resembled *Stelis* cocoons; both had a small nipple. The amber-colored inner layer of *D. rudbeckiarum* cocoons was less dense and the overwintering prepupal larvae were visible. The barrel-shaped cocoons averaged 8 mm long and 5 mm wide.

During the course of these observations, many females of *Chalicodoma* were seen landing at nests they had previously capped. The females would inspect the cap (Fig. 7), turn around, and deposit droplets of liquid from the tip of the abdomen onto the inner rim of the nest cap (Fig. 8). Females of *Dolichostelis* were not observed inspecting such nests.

These limited observations suggest that unique behavioral traits may exist in these parasites and their host. Such behavior has not been reported previously although Bennett (1966) observed that a related parasite, *Odontostelis,* that invaded nests of *Euglossa,* drove the nest owner away, opened cells of its host, removed and killed eggs or early larval instars of *Euglossa,* deposited its own egg on the provision, and resealed the cells. It appears that *Chalicodoma* females can detect parasitized nests and neutralize parasitized cells. It was not uncommon to observe females of the host bee examining, opening, and removing pollen and nectar (along with the parasite egg?) from a previously finished nest and then recapping it. One such female remained in the entrance of a nest for two days before the nest was finally recapped.

Nest usurping among host females probably does not explain this kind of nesting behavior (since females were not marked) because there were few nesting females and a surplus of available nesting sites.

During the past 15 years of collecting and observing bee nests in the vicinity of Logan, nests of *C. subexilis* have been commonly found in units provided for the alfalfa leafcutting bee, *Megachile rotundata* (F.). Not a single nest contained a cell parasitized by the *Dolichostelis,* nor have any specimens of this parasite been observed or net-collected this far north. It appears that this parasite may have extended its range and/or its available hosts recently.

Acknowledgments

We are dedicating this manuscript to E. Gorton Linsley, who has contributed many papers on the biology and taxonomy of bees, including the discovery of several new species of *Stelis*.

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